Package 'OIsurv'

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Type Package

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Description Supplemental functions and data for the OpenIntro guide to the survival package in R.

License GPL (>= 2)

URL http://www.openintro.org/stat/surv.php

LazyLoad yes

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R topics documented:

OIsurv-package *Survival analysis tutorial, a supplement to the OpenIntro guide*

Description

This package supplements the *Survival Analysis in R: A Tutorial* paper. The tutorial describes how to apply several basic survival analysis techniques in R using the `survival` package. Data sets from the `KMsurv` package are used in most examples; this package is a supplement to Klein and Moeschberger's textbook (see References).

All code used in the tutorial are included in the examples below.

Details

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URL:	http://www.openintro.org/stat/surv.php
LazyLoad:	yes

Author(s)

David M Diez

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References

Fox J (2002). "Cox Proportional-Hazards Regression for Survival Data. Appendix to An R and S-PLUS Companion to Applied Regression." Comprehensive R Archive Network. http://cran.r-project.org/doc/contrib/Fox-Companion/appendix-cox-regression.pdf

Klein JP, Moeschberger ML (2003). Survival Analysis: Techniques for Censored and Truncated Data. Springer Verlag, New York.

ReliaSoft Corporation website (2006). "Data Classification." http://www.weibull.com/LifeDataWeb/data_classification.htm

See Also

confBands

Examples

```
#=====> 2. Three packages: survival, OIsurv, and KMsurv <=====#
```

```
# install.packages("OIsurv")
# library(OIsurv)
data(aids)
aids
attach(aids)
infect
detach(aids)


#=====> 3. Survival objects <=====#
data(tongue)
attach(tongue)
mySurvObject <- Surv(time, delta)
mySurvObject
detach(tongue)

# Surv(time, event, type="left")

# Surv(t1, t2, event)


#=====> 4. Kaplan-Meier estimate and pointwise bounds <=====#
data(tongue)
attach(tongue)
mySurv <- Surv(time[type==1], delta[type==1])
(myFit <- survfit(mySurv ~ 1))
summary(myFit)

myFit$surv     # outputs the Kaplan-Meier estimate at each t_i
myFit$time     # t_i
myFit$n.risk   # Y_i
myFit$n.event  # d_i
myFit$std.err  # standard error of the K-M estimate at t_i
myFit$lower    # lower pointwise estimates (alternatively, $upper)

#pdf("kmPlot.pdf", 7, 4.5)
#par(mar=c(3.9, 3.9, 2.5, 1), mgp=c(2.6, 0.7, 0))
plot(myFit, main="Kaplan-Meier estimate with 95% confidence bounds",
     xlab="time", ylab="survival function")
#dev.off()

myFit1 <- survfit(Surv(time, delta) ~ type)  # 'type' specifies the grouping
detach(tongue)


#=====> 5. Kaplan-Meier confidence bands <=====#
data(tongue)
attach(tongue)
mySurv <- Surv(time[type==1], delta[type==1])
#pdf("confBand.pdf", 7, 4.5)
#par(mar=c(3.9, 3.9, 2.5, 1), mgp=c(2.6, 0.7, 0))
plot(survfit(mySurv ~ 1), xlab='time',
     ylab='Estimated Survival Function',
```

```
     main='Confidence intervals versus confidence bands')
myCB <- confBands(mySurv)
lines(myCB, lty=3)
legend('topright', legend=c('K-M survival estimate',
     'pointwise intervals','EP confidence bands'), lty=1:3)
#dev.off()
detach(tongue)


#=====> 6. Cumulative hazard <=====#
data(baboon)
attach(baboon)
mySurv  <- Surv(time, observed)
myFit   <- summary(survfit(mySurv ~ 1))
Hhat    <- -log(c(myFit$surv, tail(myFit$surv, 1)))
hSortOf <- myFit$n.event / myFit$n.risk
Htilde  <- c(cumsum(hSortOf), sum(hSortOf))

#pdf("cumHazard.pdf", 7, 4)
#par(mar=c(3.9, 3.9, 2.5, 1), mgp=c(2.6, 0.7, 0))
plot(c(myFit$time, 1200), Hhat, xlab='time', ylab='cumulative hazard',
     main='Comparing cumulative hazards', type='s')
lines(c(myFit$time, 1200), Htilde, lty=2, type='s')
legend('topleft', legend=c('MLE', 'Nelson-Aalen'), lty=1:2)
#dev.off()

detach(baboon)


#=====> 7. Mean and median estimates with bounds <=====#
data(drug6mp)
attach(drug6mp)
mySurv <- Surv(t1, rep(1, 21))   # all placebo patients observed
survfit(mySurv ~ 1)
print(survfit(mySurv ~ 1), print.rmean=TRUE)
detach(drug6mp)


#=====> 8. Tests for two or more samples <=====#
data(btrial)
attach(btrial)
survdiff(Surv(time, death) ~ im)   # output omitted
survdiff(Surv(time, death) ~ im, rho=1)   # some output omitted
detach(btrial)


#=====> 9. Cox proportional hazards model, constant covariates <=====#
data(burn)
attach(burn)
mySurv    <- Surv(T1, D1)
(coxphFit <- coxph(mySurv ~ Z1 + as.factor(Z11)))

coxphFit$coefficients  # may use coxphFit$coeff instead
```

```
coxphFit$var           # I^(-1), estimated cov matrix of the beta-hats
coxphFit$loglik                  # log-likelihood for alt and null MLEs, resp.

mySurvfit <- survfit(coxphFit)

betaHat <- coxphFit$coef
betaCov <- coxphFit$var
anova(coxphFit)

detach(burn)


#=====> 10. Cox PH model, time-dependent covariates <=====#
data(relapse)
relapse

attach(relapse)
N  <- dim(relapse)[1]
t1 <- rep(0, N+sum(!is.na(inter)))  # Initialize start times at 0
t2 <- rep(NA, length(t1))           # The end times for each record
e  <- rep(NA, length(t1))           # Was the event censored?
g  <- rep(NA, length(t1))           # Gender
PI <- rep(FALSE, length(t1))        # Initialize intervention at FALSE

R  <- 1                          # Row of new record
for(ii in 1:dim(relapse)[1]){
  if(is.na(inter[ii])){          # no intervention, copy survival record
    t2[R] <- event[ii]
    e[R]  <- delta[ii]
    g[R]  <- gender[ii]
    R <- R+1
  } else {                  # intervention, split records
    g[R+0:1] <- gender[ii]  # gender is same for each time
    e[R]     <- 0           # no relapse observed pre-intervention
    e[R+1]   <- delta[ii]   # relapse occur post-intervention?
    PI[R+1]  <- TRUE        # Intervention covariate, post-intervention
    t2[R]    <- inter[ii]-1 # End of pre-intervention
    t1[R+1]  <- inter[ii]-1 # Start of post-intervention
    t2[R+1]  <- event[ii]   # End of post-intervention
    R <- R+2                # Two records added
  }
}

mySurv   <- Surv(t1, t2, e)
coxphFit <- coxph(mySurv ~ g + PI)

detach(relapse)


#=====> 11. Accelerated failure-time models <=====#
data(larynx)
attach(larynx)
srFit <- survreg(Surv(time, delta) ~ as.factor(stage) + age, dist='weibull')
```

```
summary(srFit)

srFitExp <- survreg(Surv(time, delta) ~ as.factor(stage) + age, dist='exponential')
summary(srFitExp)

#===> Output is omitted from the commands below
srFitExp$coeff    # covariate coefficients
srFitExp$icoef    # intercept and scale coefficients
srFitExp$var      # variance-covariance matrix
srFitExp$loglik   # log-likelihood
srFit$scale       # not using srFitExp (defaulted to 1)
detach(larynx)
```

---

confBands *Confidence bands for a survival curve*

Description

A function for constructing confidence bands for a survival curve. This is in contrast to pointwise confidence intervals for the survival curve.

Usage

```
confBands(x, confType = c("plain", "log-log", "asin-sqrt"),
     confLevel = c(0.9, 0.95, 0.99), type = c("ep", "hall"),
     tL, tU)
```

Arguments

x	An object of class "Surv".
confType	The type of confidence ban. There are three options: "plain", "log-log", and "asin-sqrt". Entering only the first letter of the option (e.g. "p" for code"plain") is sufficient.
confLevel	Confidence level. Only numerical values of 0.9, 0.95, or 0.99 are accepted.
type	The type of method used to construct the confidence band. Available options are EP ("ep") and Hall-Wellner ("hall") confidence bands. Entering only the first letter of the option is sufficient.
tL	A minimum time to be considered. The default is the first observed or censored time.
tU	A maximum time to be considered. The default it the last observed time.

Details

See References.

Value

Returns an object of class "confBands", which is a list of three items:

time	A vector of times.
lower	A vector of the lower band values corresponding to the times.
upper	A vector of the upper band values corresponding to the times.

Author(s)

David M Diez

References

Klein JP, Moeschberger ML (2003). Survival Analysis: Techniques for Censored and Truncated Data. Springer Verlag, New York.

See Also

relapse

Examples

```
#=====> 5. Kaplan-Meier confidence bands <=====#
data(bmt)
attach(bmt)
mySurv <- Surv(t2[group==1], d3[group==1])
#pdf("confBand.pdf", 7, 4.5)
#par(mar=c(3.9, 3.9, 2.5, 1), mgp=c(2.6, 0.7, 0))
plot(survfit(mySurv ~ 1), xlim=c(100, 600), xlab='time',
     ylab='Estimated Survival Function',
     main='Reproducing Confidence Bands, bone marrow transplant')
myCB <- confBands(mySurv)
lines(myCB, lty=3)
legend(100, 0.3, legend=c('K-M survival estimate',
     'pointwise intervals','EP confidence bands'), lty=1:3)
#dev.off()
detach(bmt)
```

---

relapse *Drug-relapse of patients with time-varying covariates*

Description

Drug-relapse of patients with time-varying covariates. This data set is simulated.

Usage

```
data(relapse)
```

Format

A data frame with 300 observations on the following 4 variables.

`event` a numeric vector

`delta` a logical vector

`gender` a numeric vector

`inter` a numeric vector

Details

This data is simulated under the following pretense. Patient records were obtained for 150 days after they joined a rehabilitation program. The event of interest was drug-relapse and two covariates were recorded. The `event` variable describes the observed or censored time; the `delta` variable describes whether the time denotes an observed relapse (`TRUE`) or a censored time; the `gender` variable is a time-independent covariate; and `inter` is a time-dependent covariate indicating whether the patient had was (randomly) assigned a second intervention: working 10 hours a week for a nonprofit. Each of these special interventions were assigned *after* the patients entered the clinic, meaning the intervention covariate changes for those patients who had an intervention before relapse.

Source

Simulated (David M Diez)

References

Fox J (2002). "Cox Proportional-Hazards Regression for Survival Data. Appendix to An R and S-PLUS Companion to Applied Regression." Comprehensive R Archive Network. http://cran.r-project.org/doc/contrib/Fox-Companion/appendix-cox-regression.pdf

Examples

```
#=====> 10. Cox PH model, time-dependent covariates <=====#
data(relapse)
relapse

attach(relapse)
N  <- dim(relapse)[1]
t1 <- rep(0, N+sum(!is.na(inter)))  # Initialize start times at 0
t2 <- rep(NA, length(t1))           # The end times for each record
e  <- rep(NA, length(t1))           # Was the event censored?
g  <- rep(NA, length(t1))           # Gender
PI <- rep(FALSE, length(t1))        # Initialize intervention at FALSE

R  <- 1                          # Row of new record
for(ii in 1:dim(relapse)[1]){
  if(is.na(inter[ii])){          # no intervention, copy survival record
    t2[R] <- event[ii]
    e[R]  <- delta[ii]
    g[R]  <- gender[ii]
    R <- R+1
```

```
  } else {                  # intervention, split records
    g[R+0:1] <- gender[ii]  # gender is same for each time
    e[R]     <- 0           # no relapse observed pre-intervention
    e[R+1]   <- delta[ii]   # relapse occur post-intervention?
    PI[R+1]  <- TRUE        # Intervention covariate, post-intervention
    t2[R]    <- inter[ii]-1 # End of pre-intervention
    t1[R+1]  <- inter[ii]-1 # Start of post-intervention
    t2[R+1]  <- event[ii]   # End of post-intervention
    R <- R+2                # Two records added
  }
}

mySurv   <- Surv(t1, t2, e)
coxphFit <- coxph(mySurv ~ g + PI)

detach(relapse)
```

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